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Scheduling of Irrigation for Summer Peanuts[1]

A. R. Khan* and B. Datta

ABSTRACT

Field experiments were carried out to study the effect of moisture stress on peanut (*Arachis Hypogaea* L.) erect variety 'SB XI' in relation to amount of irrigation and IW/CPE ratio for consecutive two years of 1975 and 1976. IW/CPE denotes the ratio between a fixed amount of irrigation water (IW) and cumulative pan evaporation from US Weather Bureau Class A Open Pan less rainfall since previous irrigation (Pan E). Yield and 100 kernels weight were significantly influenced by both amount of irrigation and IW/CPE ratio. Maximum yield was obtained when irrigation was given with 6 cm water at 0.75 IW/CPE ratio.

Key Words. Yield, mositure stress, growth.

In India peanuts constitute nearly 50 per cent of the total oil seed area having an estimated oilseed and edible oil production of 67 and 59 per cent, respectively. They are grown mainly as a dryland crop. Summer season cropping with irrigation is now receiving attention as it gives increased pod yield and oil content (12).

Subramaniam *et al.* (16) observed that irrigation increased the yield and thereby water-use efficiency. Klepper (6) reported a reduction in pod yield in the tune of 50 per cent when the crop suffered moisture stress during peak flowering (50-80 days), the most moisture sensitive period. Su and Lu (15) observed the critical period of water deficiency at the peak of flowering and early fruiting in sandy soil. Bhan (1) found the stages of pegging down and pod filling to be highly susceptible to moisture stress. Water deficit depresses the economic yield much more during pod formation and maturity than during other periods (7). Matlock *et al.* (9) obtained the maximum yields of peanuts in Oklahoma State by irrigating when the soil moisture tension was 1 atmosphere. Stansell *et al.* (14) reported that pod yield and quality were significantly reduced in treatments receiving less than about 30 cm of water during the growing season and observed an increase as irrigation amounts increased from 40 to about 60 cm. Studies by Mantell and Goldin (8) showed that peanuts produced best results when the top 60 cm of soil was wet by each irrigation. All these studies emphasize the importance of the timing of irrigation to minimize moisture stress, quantity of water per irrigation and the optimum total amount of water to be added.

In order to study these factors, an experiment was conducted to find out an irrigation schedule for summer peanuts under the given agro-climatic condition in the sandy loam lateritic soil of Kharagpur, India using IW/CPE ratios with different amounts of irrigation. A modified meteorological approach based on the ratio between irrigation water (IW) and cumulative pan evaporation (CPE) as a practical guide for scheduling irrigation has been in use in recent years. The ratio will vary with the location and crop type. The method was first proposed at Washington State University (3) and was introduced for irrigation scheduling in India a decade ago.

Materials and Methods

The experiment was conducted at the Agricultural Engineering De-

[1]Contribution from the Soil Science Section, Department of Agricultural Engineering, Indian Institute of Technology, Kharagpur 721 302, India.

partment Farm, Indian Institute of Technology, Kharagpur, India during the two summer seasons, April to July, 1975 and 1976 with erect peanut variety 'SB XI'.

The experimental soil is lateritic (ultisols, pH 5.8) sandy loam; organic carbon, total nitrogen, available P, exchangeable K were 0.38, 0.054, 0.0005 and 0.101 per cent, respectively. The CEC was 6.5 meq/100 gm and electrical conductivity was 84.9 x 10^{-5} mmohs/cm. The meteorological data during the period of experimentation are presented in Table 1.

The experiments consisted of three amounts of irrigation viz., 2, 4 and 6 cm and four IW/CPE ratios of 0.45, 0.60, 0.75 and 0.90. They formed 12 treatment combinations which were replicated thrice in randomized block design. The crop was supplied uniformly with 20:60:40 kg/ha of N, P_2O_5 and K_2O through urea, single super phosphate and muriate of potash, respectively and given the same management practices. All the fertilizers were applied at the time of planting. The three levels of irrigation following four different IW/CPE ratio were maintained by recording daily evaporation loss from the US open pan evaporimeter observations. Measured quantity of water was applied using a water meter. Selected healthy kernels were hand sown at a spacing of 30 cm x 15 cm.

Results and Discussion

It is evident from Table 2 that of the four IW/CPE ratios studied, the yield of crop was significantly higher under IW/CPE ratio of 0.75 as compared to 0.45, 0.60 and 0.90 ratios in both the years. Yield reduction in the treatments with lower ratios is because of stress the crop had suffered. As inadequate supply of soil moisture has an adverse effect on productivity, the same was true of excess moisture (0.90 ratio). Lack of oxygen resulting from extended saturation condition reduced nitrogen fixation and aeration. Conclusive evidence exists that rhizobial bacteria are required by peanut for desirable growth (13). There is also a likelihood that excess irrigation water applied to this type of light soil might have reduced the effectiveness of fertilizer by leaching soil nutrients below the effective root zone. With an increase in number of irrigation the nutrient uptake may also be reduced due to poor root aeration (5). The 0.75 ratio provided the crop with adequate moisture to carry on evapo-transipiration at the reasonable rate throughout the crop cycle. Moisture regime at this ratio might have also been conducive for efficient utilization of nutrient ions and at the same time there was no harmful effect of aeration due to soil saturation. Consequently, it gave the maximum yield.

The irrigation amount of 6 cm (Table 2) produced significantly highest yield as compared to the 2 and 4 cm amount of irrigation. A majority of the root system of peanuts are generally found in the top 60 cm of soil. The roots have also been observed to develop 150 cm deep in sandy loam soil (8). Growth and fruiting occur primarily during periods when soil moisture is optimum in this effective zone. For maximum potential yield, soil depth beyond 60 cm depth should be wet with water (4). In the present investigation, in order to make the moisture optimum in the effective root zone and beyond, 6 cm net irrigation (which is closer to the storage capacity of 60 cm depth of soil, Table 3) would therefore be a reasonably better irrigation amount than 2 and 4 cm. Pande *et al.* (11) also reported the highest yield of peanut with IW/CPE ratio of 0.8 and 6.0 cm irrigation depth.

The number of irrigations and the total amount of irrigation water corresponding to different amounts of irrigation and IW/CPE ratios is reported in Table 4. The water-use efficiency was calculated as the quantity (in kg) of pod produced per ha-cm of water used. Irrigating with 4 cm amounts of water at 0.45 IW/CPE ratio gave the highest water-use efficiency followed by irrigation with 6 cm amounts at 0.75 and 0.45 ratio. The latter two combinations are statistically equal. The higher ratios of 0.90 and 1.00 have proved to be inferior in terms of water-use efficiency. It directly indicates that frequent irrigation is both wasteful of water and nutrients. Under moisture deficient regimes, even relatively small increments of water added to the soil or reduced water losses may have marked effects on yield of peanuts, which is very responsive to moisture condition. Though the actual yield under such situations may not be high, the yield increase may be disproportionately larger than the water that is used, so that water-use efficiency will be improved. This might be the possible explanation for the high water-use efficiency at 4 cm amount of irrigation water and IW/CPE = 0.45.

Table 1. Weekly rainfall, evaporation loss (US WB Class A pan evaporimeter) and variation in maximum and minimum air temperature and relative humidity.

Months	Weeks	Temperature, °C				Relative humidity, per cent				Evaporation, mm		Rainfall, mm	
		1975		1976		1975		1976					
		Max	Min	Max	Min	Max	Min	Max	Min	1975	1976	1975	1976
April	I	34.9	26.9	35.2	23.6	96.4	34.6	86.1	30.4	7.43	8.47	-	3.1
	II	42.6	29.0	38.1	23.4	98.3	35.5	97.0	22.0	10.97	9.41	11.9	0.3
	III	43.1	29.5	38.8	24.2	97.2	36.9	90.0	23.7	8.89	8.67	13.0	2.8
	IV	41.9	28.4	34.6	23.7	96.2	44.4	93.7	45.0	9.27	9.20	40.5	1.5
May	I	38.3	27.8	38.9	25.9	94.6	60.6	91.9	24.0	7.54	9.50	0.2	-
	II	40.2	26.1	37.4	25.7	88.9	29.0	84.3	44.0	8.51	7.60	1.4	19.3
	III	41.7	26.8	35.1	23.9	86.1	43.0	82.9	38.0	10.57	9.20	-	-
	IV	35.9	25.2	36.9	25.0	85.9	45.3	83.1	38.7	8.04	8.20	12.3	-
	V	38.2	26.1	38.7	26.3	91.3	43.6	89.8	33.4	8.57	9.10	-	10.6
June	I	38.0	27.2	38.9	26.5	85.9	42.1	83.3	33.4	8.30	6.50	20.0	-
	II	36.1	28.3	34.6	26.1	92.9	45.9	88.4	45.7	7.71	8.30	2.0	19.4
	III	35.5	28.4	34.2	24.6	91.6	44.8	86.8	44.4	7.76	8.80	-	-
	IV	32.5	25.1	33.4	26.1	94.4	43.4	91.0	39.1	6.97	6.80	53.2	-
July	I	33.1	25.8	32.0	25.4	94.5	54.0	90.7	63.0	6.00	5.40	-	67.3
	II	32.3	25.6	33.1	25.2	92.0	65.1	92.0	60.9	6.57	3.50	35.5	20.0
	III	31.1	27.8	33.5	25.6	77.0	58.6	91.2	60.9	3.94	3.00	-	-
	IV	31.8	27.4	32.9	25.6	72.7	58.1	95.3	62.4	9.04	4.20	43.8	15.9

Table 2. Yield and yield attributing characters of peanut crop under varying amount of irrigation (D) and IW/CPE ratios (R).

Treatments	Yield and yield attributing characters						Weight of 100 kernels, g	
	Weight of pods per plant, g		Pod yield, q ha^{-1}		Shelling percentage per cent kernel			
	1975	1976	1975	1976	1975	1976	1975	1976
Amounts of irrigation(D)								
D_1 (2 cm)	16.97	19.49	14.98	17.06	75.90	75.01	18.87	20.17
D_2 (4 cm)	18.16	20.80	16.12	18.14	75.97	75.03	19.00	21.46
D_3 (6 cm)	21.07	24.01	18.57	20.72	75.89	74.85	18.61	21.05
S.Em ±	0.224	0.581	0.194	0.679	0.334	0.163	0.138	0.852
L.S.D.(P=0.05)	0.658	1.703	0.569	1.991	1.009	0.478	0.404	2.499
L.S.D.(P=0.01)	0.895	2.315	0.773	2.707	1.372	0.849	0.549	3.397
IW/CPE ratios(R)								
R_1 (0.45)	17.08	19.63	15.06	17.41	75.46	74.62	18.39	19.70
R_2 (0.60)	18.50	21.03	16.31	18.42	75.92	75.13	18.40	20.39
R_3 (0.75)	20.25	23.10	17.85	19.96	75.85	75.11	19.50	21.98
R_4 (0.90)	19.12	21.98	17.41	18.77	76.47	74.99	18.91	21.50
S.Em ±	0.259	0.670	0.224	0.784	0.397	0.188	0.276	0.984
L.S.D.(P=0.05)	0.760	1.967	0.656	2.299	1.165	0.551	0.808	2.886
L.S.D.(P=0.01)	1.034	2.673	0.329	3.125	1.584	0.749	1.110	3.922

Table 3. Moisture storage and physical characteristics of experimental soil.

Depth	Mechanical composition (per cent)			Bulk density	Moisture retention value (per cent)		Available moisture capacity	Moisture storage (cumulative)
cm	Sand	Silt	Clay	g/cc	1/3 bar	15 bar	per cent	cm
0-20	65.07	18.33	15.70	1.55	14.29	5.81	8.48	2.63
20-40	59.35	20.94	19.63	1.52	15.23	7.70	7.53	4.92
40-60	56.70	21.00	22.26	1.50	15.80	8.35	7.45	7.15
60-80	56.70	18.00	25.26	1.48	16.00	8.21	7.79	9.46
80-100	53.46	15.87	30.39	1.40	17.21	9.92	7.29	11.50
100-120	51.46	15.87	32.39	1.40	17.75	10.63	7.12	13.49

There are instances in which the highest efficiencies of water-use is reached at a point considerably below the potential evapotranspiration. The maximum efficiency of water-use could occur even at about 90 per cent of maximum yield (2). This calls for research on the most effective utilization of limited water supply and study on economics of peanut production.

Summary and Conclusions

From the experimental result it may be inferred that in the prevailing agro-climatic conditions, peanut variety 'SB XI' can be successfully grown during the summer months with irrigation scheduled at IW/CPE ratio of 0.75 with each irrigation of 6 cm depth. This combination will produce the maximum yield potential of peanuts. Following this practice, pod yield of about 20.19 and 21.85 quintals per hectare could be harvested with shelling percentage of 76 and water-use efficiency to the extent of 57 and 59 kg/ha-cm in the year 1975 and 1976, respectively. Almost similar water-use efficiency was also obtained with 0.45 ratio with 6 cm irrigation depth, but the latter did not compare with 0.75 ratio since it could not realize the optimum yield potential of peanut.

Table 4. Number of irrigation and water-use efficiency as influenced by varying amount of irrigation (D) and IW/CPE ratios (R)

Treatments		Number of irrigations		Amount of water applied through irrigation, cm		Rainfall during the crop season, cm		Total amount of water applied, cm		Pod yield, q ha^{-1}		Water-use efficiency, kg ha cm^{-1}	
		1975	1976	1975	1976	1975	1976	1975	1976	1975	1976	1975	1976
D_1	R_1	6	7	12.00	14.00	12.45	14.89	24.45	28.89	13.11	15.92	53.62	55.10
	R_2	9	9	18.00	19.00	9.98	11.85	27.98	30.55	14.73	16.66	52.64	54.00
	R_3	10	10	21.00	20.00	9.00	13.40	30.00	33.40	16.16	18.47	53.87	55.30
	R_4	11	12	22.00	24.00	10.01	9.08	32.01	33.08	15.91	17.20	49.71	52.00
D_2	R_1	3	3	11.00	13.00	13.03	12.50	24.03	25.50	15.19	16.57	63.20	65.00
	R_2	4	5	21.00	19.00	11.00	15.44	32.00	34.44	15.83	17.91	49.46	52.00
	R_3	5	6	25.00	24.00	11.00	15.72	36.00	39.72	17.20	19.56	47.78	49.25
	R_4	6	9	31.00	34.00	13.00	12.53	44.00	46.53	16.28	18.52	37.00	39.80
D_3	R_1	2	3	15.00	16.00	15.00	17.47	30.00	33.47	16.89	19.75	56.30	59.00
	R_2	4	4	22.00	25.00	14.00	13.65	36.00	38.65	18.36	20.68	51.00	53.50
	R_3	4	4	21.00	24.00	14.50	13.04	35.50	37.04	20.19	21.85	56.88	59.00
	R_4	7	7	41.00	42.00	13.01	11.64	54.01	53.64	18.84	20.60	34.88	38.40

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